THE

VETERINARY JOURNAL

Editor :

FREDERICK HOBDAY, C.M.G., F.R.C.V.S., F.R.S.E.,
HONORARY VETERINARY SURGEON TO HIS MAJESTY THE KING,
OFFICIER DU MÉRITE AGRICOLE (FRANCE),
CAVALIERE DEI SS. MAURIZIO E LASSARO (ITALY),
HONORARY MEMBER OF THE AMERICAN VETERINARY ASSOCIATION,
PRINCIPAL OF THE ROYAL VETERINARY COLLEGE, LONDON.

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Sub-Editor :

GLADSTONE MAYALL, M.R.C.V.S.

JULY, 1930.

THE FORTHCOMING INTERNATIONAL VETERINARY CONGRESS.

It is our intention, as on the occasion of the Tenth International Veterinary Congress, to publish a Special Congress Number of the VETERINARY JOURNAL, and in this present issue we draw the attention of every member (and intending member) of the profession to the fact that it is a duty which we all owe to science and to our profession to support this gathering which will be assembled in London between 3rd and 9th of August.

The subscription (30/-) is within the range of everybody and, from the literature alone which every member receives, he reaps ample reward; whilst, by the thoughtfulness of the Council, a college student can have all the privileges of membership upon payment of the small sum of ten shillings only.

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The scientific material provided for discussion covers a very vast range of subjects and includes papers on diseases affecting every species of domesticated animal and bird ; whilst the names of the essayists who have accepted the invitations to deliver the addresses are amongst the most celebrated in the world. From the large numbers of members who have already signified their intention of being present there can be no doubt that the Eleventh International Veterinary Congress will be a great reunion—one, too, in which the last traces of the friction caused in scientific and other circles by the Great European War of 1914, will be removed. That we may return to the plan of a Congress every four years is, we are sure, the wish of everybody.

The older generation of Veterinarians have been somewhat foolish in that they have been apt to take too little interest in the social side of life. Whether it was from love of solitude or general shyness it is difficult to say, and it is interesting to watch the alterations which are taking place in this respect in the habits of the younger generation of assistants ; who usually specify that they shall have, as a matter of right, almost as much time off for pleasure as they give up to the service of their employer.

General Articles

DISTEMPER AND THE ANTI-VIVISECTION SOCIETIES.

By FREDERICK HOBDAY, C.M.G., F.R.C.V.S., F.R.S.E.,
President of the University of London Animal Welfare Society and Vice-president of Our Dumb Friends League.

On numerous occasions recently various anti-vivisection societies have exhibited ghastly posters and distributed leaflets attacking medical and veterinary research, especially the recent Distemper investigation.

Distemper is the most serious of all the canine scourges, and I will take this as one of the diseases by which I propose to illustrate the protection afforded to animals by the anti-vivisection laws in this country. If, upon extended trial, this immunising vaccine treatment proves as successful as we have reason to hope it will as a means of preventing distemper, the saving of misery to our canine patients, to say nothing of the saving of distress to owners to whom the loss of a canine pal means intense grief, will be inexpressible in words.

Is it not unjustifiable, therefore, for anyone, and especially for an Animal Humane Society, to try to belittle this scientific work which is destined, if true, to save literally millions of lives?—and not only to save the lives and suffering of the dogs but to save hours of toil and anguish to the owners—to say nothing of the monetary value it puts on the puppies and the greater pleasure it gives and freedom it allows for them.

The practice of vivisection in this country to-day is very strongly controlled by an Act of Parliament, a copy of which anyone can get at the Stationery Office for 1s. 3d., entitled "Experiments on living animals." It is a pamphlet of some 66 pages which gives not only the official report but a list of all who hold licences, all licensed places, and a full explanation of the clauses and conditions of the Act. It makes one see quite plainly that the words "Vivisection" and "Experiment" require considerable discretion in their explanation, and would be better transposed into other names which do not sound so gruesome.

The actual word "Vivisection" should only be used to describe some cutting operation without an anæsthetic—which is the sense the word conveys to the "man in the street."

The word "Operation" might be used for experiments involving operations under anæsthetics, for such are done with exactly the same

antiseptic and routine care as they are done on human beings every day in our hospitals.

The word " Observation " might be used for every other procedure not involving a cutting operation.

If this nomenclature were adopted there would be no " *Vivisection* " experiments to record in England to-day ; for no operation on animals—" operation " in the sense understood by the general public—is permitted without full surgical anæsthesia.

The efforts made to find a cure or preventive for distemper have been violently decried in certain sections of the Press, and illustrated pamphlets have also been issued broadcast by certain societies, because the research workers held so-called Vivisection Licences ; whereas it was owing to the stringency of our English cruelty to animals laws that even for a comparatively few injections it was necessary, in order to keep out of the clutches of the law, for those working at this fell disease to obtain official licences so that they might put their results into concrete form and spread the good news broadcast for the prevention of the disease amongst other dogs.

By way of explanation let us take extracts from the Cruelty to Animals Act of 1876, which was introduced into Parliament purposely " to control cutting experiments usually performed in Medical Schools and Physiological Laboratories "—and in those days there was so very little known about bacterial diseases that many thousands of so-called " experiments " (I refer to milk and drug tests) were not then even thought of—and if the Act was rewritten they would be classified merely as " observations."

The first clause in the Act says that the law is amended in order to extend its powers of control over the cases of animals which for medical, physiological, or other scientific purposes, are subjected when alive to experiments calculated to inflict pain—i.e. in which pain may arise—and states definitely that " a person shall not perform on a living animal any experiment calculated to give pain, except subject to the restrictions imposed by this Act " ; and the experiment must be performed with a view to the advancement by new discovery of physiological knowledge, or of knowledge which will be useful for saving or prolonging life or alleviating suffering. The observer, or experimenter, must be a person holding a licence from one of the Principal Secretaries of State, and the observations, or experiments, have to be made in a duly licensed or registered place ; all of which are carefully inspected at unexpected hours. It is only under special circumstances that an animal upon which any surgical operation has been done is allowed to return to consciousness. The operation itself is not painful, as it is done under surgical anæsthesia.

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At a Dog Show, at which thousands of dog owners and dog lovers attended, I had a paper put into my hand upon which there were such astounding accusations against the humanity of Christian England that, as a member of the profession whose mission in life is to endeavour to alleviate the sufferings caused by disease amongst animals, I was struck with amazement ; and I wondered if it could possibly be true. I also reflected that if it had this effect upon *my* mental outlook, its effect upon those who knew nothing about the great, relentless, way in which disease germs work, but who impulsively look only upon the sentimental side of things, must be akin to that of horror—and again I wondered if the figures in front of me were placed before the animal loving public in a fair and square British fashion.

I read, for example, the statement that no less than 293,302 "*experiments*" were performed upon animals in the year 1927, and this number was 36,824 greater than in 1926 ; whilst another pamphlet stated that " 315,891 vivisection operations were done in the British Isles alone in 1928 " ; and that " these included such perfectly futile things as dropping dogs from great heights to observe the effect " ; and " fastening animals together until they grow together."

The word " experiment " grated on my mind, as it led me to picture all kinds of dreadful things being done upon all kinds of friendly, helpless animals, and this feeling was increased when I read that (in 1927) only 12,871 were stated to have been performed with anæsthetics. This left to the imagination the statement that some 279,431 so-called experiments had been done without any anæsthetic at all ; and I still pictured a very horrible and bloodthirsty state of affairs. So much did this impress itself on my mind that I wondered what our police could be doing to allow so much " cruelty " and what our legislators could have omitted when, at the instigation of the supporters of certain Animal Humane Societies, they passed the Cruelty to Animals Act in 1876. Especially did I think in this vein because I had been given to understand that this Act was especially introduced to control the cutting experiments usually performed in Medical Schools and Physiological Laboratories. In those days very little was done in regard to inoculation work either for the control or the transmission of disease. These 279,431 so-called " operations " were inoculations, or drug testing for standardising purposes. Can anyone suggest another way of carrying out these necessary details ?

It is most difficult to obtain what is called a Vivisection licence, and it is only after the most careful scrutiny of one's credentials that permission is given to use animals even for food tests. The application must be signed by one or more of nine Presidents of Bodies of such high integrity as the Royal Society, the Royal Irish Academy, the

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Royal College of Surgeons or the Royal College of Physicians, the General Medical Council, the Royal College of Veterinary Surgeons, and, having obtained one or other of these, the applicant must also get the signatures of a Professor of one of the great branches of human medicine, before sending it to the Home Office for consideration. When granted the applicant is under the most rigorous rules in regard to inspection and to the restrictions against deviating from the actual work which the licence covers. One must not forget, too, that in many instances the possession of several certificates does not necessarily mean more animals "vivisected." Often the more certificates one holds the more mild one's experiments. For example, in looking at the report I read that no less than 278,041 so-called "experiments" were performed under Certificate A, and when I look up Certificate A, I am at first horrified to read that "Certificate A dispenses altogether with the obligation to use an anæsthetic," which again might convey a wrong impression. What it really indicates, however, is that those were inoculations or hypodermic injections or feeding experiments, the majority of which were food, cod liver oil, milk, or such like observations on rats or guinea pigs, or testings done to standardise drugs before allowing them to be put on the market for the use of man or veterinary patients. *Even to work at anæsthetics themselves, and be able to publish the results one has to have a licence—in fact two or more—and this is a further proof of the control given by our laws over this work.*

This was my own position when, in 1895, I was compelled to hold various licences (including the special one by which the animal was allowed to return to consciousness and live) in order that certain work which I did (which established the safe percentage of chloroform vapour and the dosage of cocaine) which could be utilised with safety for surgical operations on dogs and other animals.

The holding of a so-called Vivisection licence has been a necessary adjunct in the case of the observations, or so-called experiments, carried out in order to discover this valuable preventive serum against distemper, and *it is a very great argument in favour of the protection afforded to animals when, in the fight against disease, it is impossible to do even preliminary experimental work upon any living creature without obtaining official legal Parliamentary permission.*

A still further proof of the stringency of our Anti-Cruelty Laws.

Even in the case of the dog (an animal which is especially dear to the home of every Englishman and a source of substantial income nowadays to almost every practising veterinarian), the question of observational work must be considered with sanity and in regard to "the greatest good for the greatest number." There are some who would never permit a dog to be used at all for any observational work

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which is intended to benefit man or even its own species, and there must surely be some inconsistency in this. One has only to take a disease such as distemper by way of illustration ; a disease which kills its thousands, many of them after a lingering or painful death, every year. If the violent opponents to the use of a few dogs in an endeavour to cure or prevent a disease such as this, would only think for a moment of the benefit to the whole canine race which will follow the discovery of the means of prevention of this one disease alone, they would surely never need to be argued with.

Take again the great work which has been done by Dr. and Mrs. Mellanby for the prevention of rickets in children and in animals. By certain observational work on feeding, the value of the necessity for a properly balanced diet has been so clearly demonstrated that even the man in the street thinks he knows (often even more clearly than his medical attendant) what is meant by the word " vitamin."

The blessing conferred on human beings by the anti-toxin against diphtheria, obtained from the blood of horses, a material which cannot be obtained in any other way, is another illustration of the valuable result of experimental work upon animals.

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Anti-Vivisection Societies, if confining themselves to the words " Vivisection " and " Experiment," will always receive the whole-hearted support of the veterinary profession, provided they will confine themselves to the prevention of unnecessary or avoidable cruelty, but the word " Vivisection," as it is used for propaganda purposes to-day, is a misnomer ; and indeed, as I have already said, the word " experiment " would be more truthfully expressed by the word " observation."

There would be a great deal of difference in the minds of the emotional public, if, in the publication of their propaganda, some of the more spectacular anti-cruelty societies truthfully dissected out the real " vivisection experiments " from those which could be put into the category of observational work, for it *is not fair to make the unqualified and bare statement to an emotional public that so many " tens of thousands " of experiments were done under the Vivisection Act Laws*, thus putting before their eyes a vivid picture of a dog being strapped down to a table and cut up with a knife in horrible fashion, *forgetting to mention that by law the animal is bound to be properly chloroformed ; and also, that nine-tenths or more of these statistics were food or other non-painful observations or experiments performed on rats and guinea pigs, or rabbits.*

Unfortunately, we have to live in a world in which everything and everybody is more or less cruel, and although societies for the protection of animals are excellent institutions, it is not good for them to be administered by cranks, many of whom would be normal people if only

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they had children to earn livings for and less time to brood over their own fancied wrongs.

The veterinary surgeon, from the personal respect with which he is looked up to by his clientèle, can do a great deal to influence true humanity to animals; and if we are dissatisfied with certain things, whether it be the ravages of disease or whether it be some method of killing animals for food, it is for us to do our best to strive to put the matter right. By our individual examples we can help the world forward by pioneering a practical teaching based on humanity without fads.

It is worth while to quote what one of our most celebrated preachers wrote on this subject in the Daily Press a few days ago: The Very Rev. Dean Inge, D.D., the well-known Dean of St. Paul's Cathedral, in the *Evening Standard* wrote (under a paragraph headed "Vivisection and Hysteria"), "As for vivisection I believe it is necessary for medical research, and not necessarily very cruel. But I am far from thinking vigilant control unnecessary."

One of the printed pamphlets distributed broadcast at the above mentioned Dog Show bore a picture of a villainous looking man holding a hypodermic syringe, at least a foot long, and looking with gloating eyes at a little dog, to which he addresses some such words as "You are a nice healthy little dog, I will give you Distemper." By such leaflets the British Union for the Abolition of Vivisection (Dr. Hadwen's Society) seeks to stir up the British public against veterinary research in this country.

It is not in the interests of dogs themselves that purely propagandist bodies of this type should be given opportunities of trading on the hearts of dog lovers, nor is it in the interests of true humanity. If those who set up such lines of reasoning could, by constructive criticism, show better methods, their ideas would be welcomed—but to oppose support being given to those who devote their lives to the search for methods of alleviating animal suffering is cruel in the extreme.

A NOTE ON "AVERTIN" ANÆSTHESIA IN THE CAT.

By J. G. WRIGHT, F.R.C.V.S.,

Professor of Therapeutics and Pharmacology, Royal Veterinary College, London.

FURTHER work with this drug shows us that it is of considerable value to the general practitioner; particularly as a means of effecting deep narcosis in the cat. For the dog we have at our disposal in morphine, a very serviceable narcotic; but up to the present in cats we

have always had to adopt anæsthesia by the inhalation of $CHCl_3$. The practice is not free from risk and often presents difficulties to the single-handed practitioner.

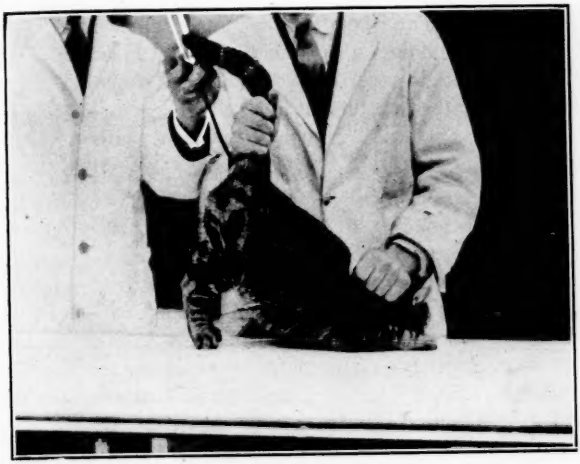

Fig. 1. Method of holding animal during injection. This position is kept until narcosis occurs.

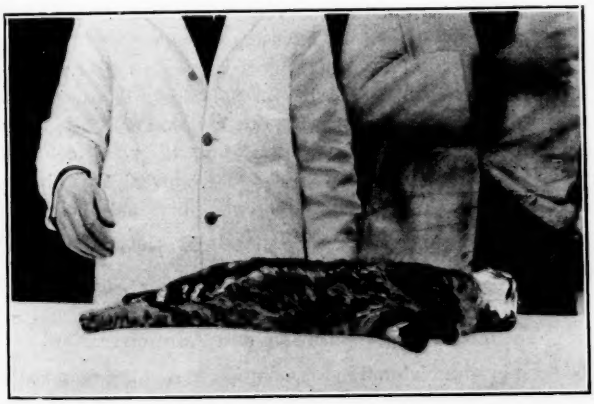

Fig. 2. Five minutes after injection; general anæsthesia.

In a series of 40 cases we have had consistent results. The animals have varied in age from 3 months to 10 years and in body weight from

2¾ to 13 lbs. The dosage we have adopted is 0.3 c.c. fluid " Avertin " per kilogramme body weight. The onset of profound narcosis occurs in from 3 to 10 minutes and persists for a period of from 12 to 24 hours. The degree of narcosis varies from a deep stupor to a general anæsthesia with complete muscular relaxation with loss of all reflexes. We have found that with the dosage above mentioned that in animals under six months old, narcosis is not so deep as in animals over that age. Complete surgical anæsthesia is present in about 50% of cases and in others it is necessary to augment " Avertin " by a few whiffs of $CHCl_3$. No restraint is ever necessary.

The induction of narcosis is never associated with any violent stage of excitement ; although a little muscular jerking may occur at about the 3rd minute after injection. The sensation appears to be a delightful one for we have never had a cat attempt to bite or scratch when becoming narcotised by " Avertin," and during the later stages of narcosis they assume an attitude of natural sleep, often accompanied by purring. The persistence of the narcosis serves the useful purpose of preventing the animal interfering with surgical dressings in the first 24 hours after operation.

That the agent is not entirely free from risk we are well aware. It will be readily understood that any agent having such a profound effect upon the C.N.S. is, of necessity, associated with a risk of circulatory or respiratory failure ; and for this reason we urge that in every case the animal be weighed and the dose computed according to its body weight.

In the series mentioned we have had two deaths. In one, an 11 years cat suffering from a purulent pleurisy, the result of a perforation of the œsophagus, death occurred in 24 hours. Toxæmia was, no doubt, a contributory cause. In the other, however, a 12 months cat, death occurred 4 hours after anæsthetisation, the result of circulatory failure. *Post-mortem* examination failed to reveal any abnormality and in this case we are led to assume some individual idiosyncrasy.

Quite apart from its value as an anæsthetic, the drug will be found of use, in small doses, as a cerebral sedative and pain reliever.

Technique of Preparation and Administration.

The drug is administered in 3% solution in distilled water at 40° C., via the rectum into the colon. I append a table showing dosage and dilution according to the various bodyweights in both the metric and imperial systems.

In the great majority of cases the patient has been in no way prepared ; but it is advisable to withhold food for six hours prior to

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injection and in cases where the rectum is packed with hard fæces a dose of castor oil 12 hours previously.

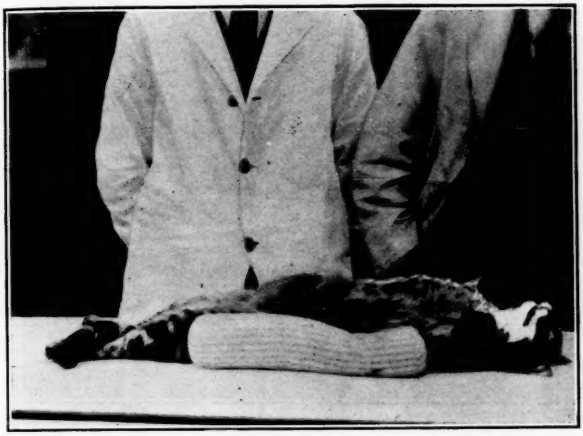

Fig. 3. Animal placed in position for operation. No restraint is necessary.

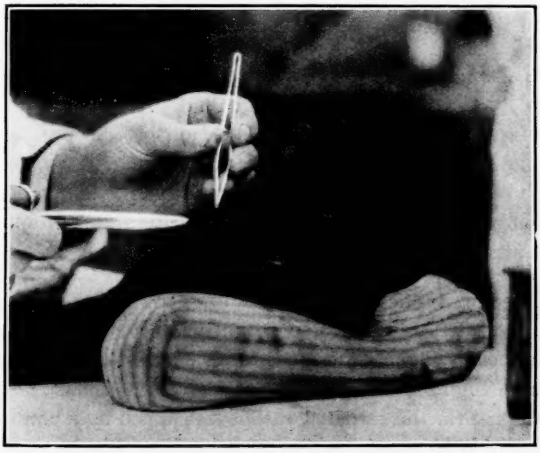

Fig. 4. Enucleation of the eyeball under "Avertin" Anæsthesia.

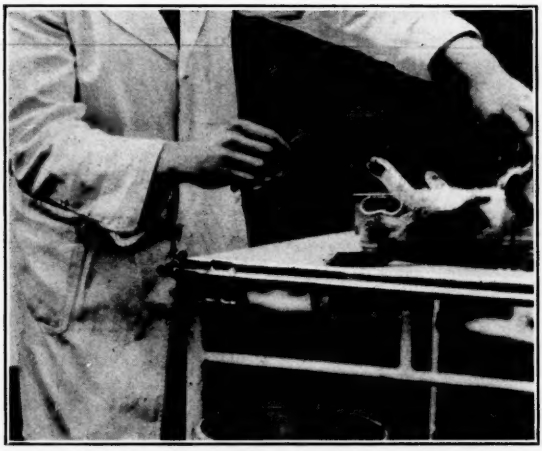

Fig. 5. Castration of the adult cat, under "Avertin" anæsthesia. Note the complete muscular relaxation.

A No. 9 catheter is lubricated and passed into the colon via the rectum six to eight inches. (The method of holding the animal will be seen from the accompanying photograph.)

Distilled water of sufficient quantity for a 3% dilution is heated in a flask to 40° C. (104° F.) and then the fluid " Avertin " is added and agitated for 3-5 minutes until completely dissolved. One next tests 5 c.c. of the liquid, which is now ready for injection, with two drops of a solution of Congo red (supplied by the makers). Decomposition is indicated by acidity, the Congo red turning from pink to blue ; and this may arise from excessive heating.

The injection is effected by means of a glass wound syringe. The liquid, provided it is properly prepared, is entirely without irritant effect and never acts as an enema. It is best, however, to keep the animal with the hind parts raised until narcosis occurs. To prevent liquid escaping *via* the catheter, the end is clipped by a pair of artery forceps.

The catheter is best withdrawn when narcosis is effected.

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Dosage Table.

A. *CATS*—0.3 gm. per kilogramme body weight.
(In cases of excessive weight due to fat, reduce to 0.2.)

Weight.		"Avertin."		Solution for use 40° C. Distilled Water.		
Pounds	or Kilos.	C.C.S.	or *Minims.	†C.C.S.	or Ozs.	Drachms.
3	1·3	·4	7	12		3½
4	1·8	·5	9	18		5
5	2·3	·7	11	23		6½
6	2·7	·8	14	27		7½
7	3·2	·9	16	32	1	1
8	3·7	1·1	18	36	1	2
9	4·1	1·2	20	40	1	3½
10	4·5	1·3	22	46	1	5
11	5	1·5	25	50	1	6
12	5·4	1·6	27	54	1	7½
13	5·8	1·7	29	58	2	½
14	6·3	1·9	32	63	2	2
15	6·8	2·1	35	70	2	4
16	7·3	2·2	37	73	2	5
17	7·7	2·3	39	76	2	5½
18	8·2	2·5	42	83	2	7½
19	8·7	2·6	44	86	3	½
20	9	2·7	46	90	3	2

* Plus 2 Minims for testing. †Plus 5 c.c.s. (80 Minims.) for testing.

MILK FEVER—SOME VIEWS AND EXTRACTS.

By G. MAYALL, M.R.C.V.S.

Since early days views on the etiology of milk fever have changed with almost chameleon-like regularity. Most of us who have been in practice over 30 years will remember various theories (cerebral anæmia, cerebral congestion, uterine or udder disturbance, toxæmia, anaphylactic shock) that have been held with vice-like tenacity by numerous enthusiasts for short or long periods. They have all succumbed to the great law of change. The modern outlook varies between hypoglycæmia and hypocalcæmia. From their researches Dryerre and Greig believe that there is a parathyroid deficiency causing a hypocalcæmia.

Otte observes that cows affected with milk fever eliminate sugar in the blood and this complicated metabolism of hydrocarbonates has been the subject of much research by physiologists. The metabolism is far from being completely known. We do not yet know exactly under what form the molecule of glucose is assimilated by the tissues. If all the overplus of glucose emptied into the blood is rapidly eliminated one cannot say whether the glucose is delivered to the tissues under the form of triose or under that of calcium-glycogen. If the decomposition of glucose does not take place from any cause whatever (failure of hormones for example) the excess of the sugar of the blood is eliminated by the urine, whilst the system and the tissues suffer from an insufficient supply of hydrocarbonated substances. Maguire, Auger, Widmark and Carlens have all obtained good results by administration of glucose. Hepburn, le Q. Blampied, E. C. and L. W. Bovett and A. Payne have all reported successes with calcium gluconate whilst J. F. D. Tutt reports non-success with the same means in five cases and R. Hancock reports success with intravenous injection of calcium chloride. Widmark and Carlens found that the comatose state in milk fever is coincident with a fall in the sugar content of the blood below 0.035 to 0.037 per 100. They do not consider, however, that milk fever is due entirely to modifications in the sugar content of the blood. They found that the sugar content of the blood only falls below the average in cows lightly affected with milk fever, whilst in comatose cows gravely affected the sugar content of the blood was raised above the normal. But coma as Otte (B. T. W. May 3rd, 1929) observes may ensue not only from hypoglycæmia but also from other pathological states, notably insufficient oxygen content of the blood, and in cases of thrombosis of the ramifications of the carotids. In cases of intoxication by carbonic oxide or accumulation of carbonic acid in the air we may notice vertigo, syncope, œdemas, and sugar in the urine.

The graver the case of milk fever the more the sugar cypher in the urine is raised, a fact recorded by Nocard. Cows badly affected also show acetone in the urine, a fact which has induced Otte to pursue researches in a definite etiological direction.

He mentions that milk fever in cows does not always follow parturition, thus Schreiber had a case six weeks after calving, Popescu three months after and other observers have noticed the malady at various periods unassociated with parturition.

Otte goes on to write that whoever has examined good milch cows before parturition will find not only œdemas of the abdomen but a quickened respiration.

At the clinic in Leipzig, Richter found at the end of gestation, in cows of normal health that the respirations were 86 and the pulse rate

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120 per minute and the temperature 104.9 F. (normal P. 68 R. 28 T. 101.3). Otte considers that these symptoms are connected with the increased intensity of oxydations.

We know that milk contains 3.6 per cent., average 4.5 per cent. of lactose. If a cow gives 20 litres (say 5½ gals.) of milk a day, its system should produce 90 grammes of lactose equal to 180 grammes of glucose. The starch ingested with the food being incapable of furnishing such a large quantity of sugar has recourse to its reserves, to the fat which is transformed into glucose. We do not know much about the phenomena of oxydation and hydrolysis, but we do know that by oxydation we can transform glycerine into glycerose ($C_3 H_8 O_3 + O = C_3 H_6 O_3 + H_2O$ or $CO(CH_2 OH)_2$). The investigator Fisher has also proved that under the influence of alkalines, two molecules of glycerose can combine to form glucose. It may be admitted in short that fatty acids set at liberty are transformed by oxydation into glycogen or glucose. The stearic acid $C_{18} H_{36} O_2 + 16 O = 3 C_6 H_{12} O_6$. The metabolism of calcium depending on glycogen, the animal cell can only receive the salts of calcium with the aid of glycogen. If the stearic acid be transformed into glycogen one understands the efficacy of the treatment of rickets by irradiated stearine, without needing to invoke the action of a hypothetic vitamin. Glycerose is made up of aldehyde of glycerine and dioxyacetone. If by a failure of oxygen the organism cannot transform the fatty acids and the glycerose these bodies form acetone in an acid medium. The appearance of acetone in the urine shows that the decomposition of fats has taken place in the presence of an insufficient amount of oxygen, a phenomenon observed in milk fever. Otte is of the opinion that these chemical transformations occur in the liver and udder, thanks to the hormones of the blood.

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We can therefore compare milk fever to diabetic coma of man. In milk fever the blood is thick and coagulates easily because it is surcharged with proteids and hydrocarbonated substances; the vascular tone is lowered; the capillaries are obstructed; the veins seem to be dilated and the lacteal secretion arrested. It is clear that under such conditions circulatory troubles notably to the posterior limbs may arise.

In milk fever the system is lacking in water; the digestive tract is dry as a result of hydrolytic action. If the pulmonary respiration is not equal to assuring a sufficient supply of oxygen the system may possibly take up its oxygen from its water. The following test proves this. If one cuts out a small fresh fragment of a quarter of the udder and places it in a jar of water at 98.6 F. it may be seen at the end of a certain time that the tissue is covered with bubbles of gas which slowly rise. If one adds a few drops of perhydrol an intense decomposition of the water is produced with the production of oxygen whilst

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the fragment of udder tissue rises to the surface. The same phenomenon may be observed with other tissues rich in glycogen, such as fragments of a nematode worm. The experience here also explains the mode of action of air insufflated into the udder.

For the differentiation between cerebral congestion and milk fever in the cow an analysis of the urine may be made. Sugar and acetone are not present in the urine in cerebral congestion. Certain cases of ante post partum paralysis have a thrombitic origin.

Besides the classic treatment of Schmidt, Carlens and Widmark have recommended intravenous injection of glucose. Otte considers that in grave cases results with this are not so good as with Schmidt's treatment which is more simple and less costly. Glucose acts above all as a stimulant to the vascular tone and renders superfluous a strong decomposition of the fats, a decomposition which increases the needs of oxygen.

If this hypothesis is exact it is important to ensure a material supply of oxygen and water and to assure a regularising of the metabolism of hydrocarbonates which cause acidosis of the blood to disappear and raise vascular tone. Greig and Dryerre believe that intra-mammary injection of air produces apparent stimuli causing increased activity of the adrenals and stimulation of the liver to produce glucose and also that by dilation of the udder lactation is arrested and exchange of calcium from the blood of the milk prevented. Otte believes that *the effects of air injected into the udder are not purely mechanical, vasomotor and reflex: the air stimulates the cellular respiration of the udder. The need for oxygen being very intense, the oxygen that arrives there with the air exercises the most favourable action.*

With this hypothesis before us there is still something to be said for inflation of the udder and the few cows that have not got up with me have risen and done well when also given a full hypodermic injection of oil of camphor 1 in 5. In one case with deep recurring coma Otte got recovery with injection of sugar and bicarbonate of soda in water, injection of the udder with distilled oxygenated water and glykozymine subcutaneously.

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A WIDESPREAD OCCURRENCE OF XANTHIN CALCULI IN SHEEP.*

By T. H. EASTERFIELD, T. RIGG, H. O. ASKEW and J. A. BRUCE,

Cawthron Institute, Nelson, New Zealand.

Introduction.

XANTHIN (2·6 dioxypurin) has been recognised for more than a century (1) as a rare constituent of urinary calculi. It is present in human urine (2, 3) and the amount is increased during inflammation of the kidneys (4). Its presence in the urine of sheep (5) and of pigs (6) was recognised at an early date. It occurs in blood, the muscles and many of the glands of animals and is widely distributed in the vegetable kingdom. This common occurrence is not surprising since xanthin is a regular though secondary product of the hydrolysis of nuclein (7, 8). Owing probably to the action of xanthin oxidase in the liver and other organs, the quantity of xanthin in urine and blood, under normal conditions, is very small and concretions of this compound are regarded as almost the rarest of urinary calculi.

During the course of an investigation at the Cawthron Institute into the mineral contents of Nelson pastures, the occurrence of stone in the kidneys of sheep was pointed out by several farmers in different parts of the Waimea County. Further inquiry and the careful examination of a number of kidneys showed :

(1) that on some farms kidney calculi were very prevalent ;

(2) that in every case the calculi consisted of xanthin ;

(3) that serious loss of stock from calculus trouble was restricted to farms on one particular soil type which was of low fertility.

These facts suggest that this abundant occurrence of xanthin calculi may be caused by deficiencies in the pastures associated with the soil type in question. The analyses in connection with a comprehensive soil survey of the Nelson district by the agricultural division of the Cawthron Institute had already shown that the soil is very deficient in lime and phosphoric acid. The presence of calculi in the kidneys of cattle fed on a phosphate deficient diet has been noted in South Africa (9) ; the chemical nature of these calculi was not however stated.

The occurrence of xanthin calculi amongst stock pastured upon one particular type of soil suggests many questions of physiological interest.

(1) Can a deficiency of certain elements in the soil increase the formation of xanthin or its precursors in the fodder ?

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(2) Can an unbalanced mineral ration cause a partial or complete arrest of pure metabolism at the xanthin stage by reducing the secretion or activity of xanthin oxidase ?

(3) Can the mineral ration affect the purin metabolism at other stages and thus have a bearing on the guanin deposits in pigs and uric acid calculi in other animals ?

(4) Is xanthin accumulation and deposition merely determined by some simple cause such as a change in the *p*H value of the blood or urine ?

It is proposed to initiate feeding experiments on the formation of xanthin calculi.

Occurrence of the Calculi.

All the calculi which have come to the notice of the authors have been taken from stock raised on soil of the Moutere Hills type. This soil covers an area of 300-400 sq. miles stretching as a belt nearly 50 miles in a north to south direction from Motueka in Tasman Bay to Top House at the foot of St. Arnaud's Range. Cases have been seen or reported from eight districts, but the occurrence has been most striking in Pigeon Valley near Wakefield.

In this valley, on one small farm grazing 120 sheep, 10 sheep have been found in the last six months with kidney calculi as a predisposing cause of death. The owner can pick out the badly affected sheep by their appearance and killed two sheep in the presence of the authors to demonstrate this. In both cases the kidneys were badly affected.

No instance of calculus trouble has been reported in the case of sheep reared on the more fertile soils of the Waimea County. On the few areas of Moutere Hills soil where, by lime and phosphate treatment, good pastures have been established the presence of calculi in the kidneys of sheep has likewise not been recorded.

Though the calculi generally consist of a gravel made up of a mixture of large and small stones with particles as fine as dust (Fig. 1) a calculus from Harakeke represents a complete cast of the enlarged kidney pelvis. The specimen weighs 36 gm. (Fig. 2). Small stones are frequently found in hoggets which are in sufficiently good condition to warrant their slaughter for meat.

Large stones may occur in both hoggets and full-mouthed sheep. Wethers and ewes seem equally affected. Several farmers have stated that they have found similar stones in the kidneys of cattle and hares on Moutere Hills country but none of these calculi has come under the immediate notice of the authors.

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Identification of the Xanthin.

Though the calculi from the sheep on the Moutere soil are of a light grey stony appearance, suggestive of calcium carbonate or phosphate, they have proved in every case to be composed of xanthin, $C_5H_4N_4O_2$. This is remarkable since xanthin calculi are regarded as extremely rare.

In a particular case the dried calculus left only 0·1 per cent. of ash on ignition. It contained 35·35 per cent. of nitrogen, which is surprisingly near to the value 36·8 per cent. required for pure xanthin. After purification by solution in ammonia, decolorisation with animal charcoal and reprecipitation by spontaneous evaporation of the ammonia, the xanthin was obtained in characteristic microscopic globules containing 36·6 per cent. of nitrogen, thus agreeing well with the calculated value.

The xanthin showed the following qualitative reactions which confirm its identity :

(1) It dissolved in ammonia and more readily in caustic soda and was reprecipitated by dilute acetic acid.

Fig. 1. Swollen sheep's kidney full of xanthin gravel.

(2) Evaporated to dryness with nitric acid it left a yellow residue which gave a yellow solution with ammonia and deeper yellow with caustic soda. The soda solution became purple-violet when gently warmed.

(3) Evaporated to dryness with hydrochloric acid and chlorate of potash it left a residue which turned violet with ammonia.

(4) The solution in baryta water upon treatment with diazotised sulphanilic acid yielded a brick-red precipitate (10).

Symptoms shown by the Affected Sheep.

Affected sheep are frequently in poor condition. In a number of cases there was no fat surrounding the kidneys (Fig. 3). Two 2-toothed

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sheep with large calculi in the kidneys had a live weight of 49 lb. and 52 lb. respectively. Healthy sheep of the same age should weigh not less than 80 lb. In severe cases the sheep mope around the paddocks and show little inclination to graze. Frequently such sheep have arched backs with the hind-legs drawn under the body (Fig. 4). There appears to be great difficulty in urination and the sheep may be seen straining frequently. One sheep badly affected was distinctly anæmic in appearance.

In severe cases one or both kidneys may be greatly enlarged and full of calculi.

Sometimes rupture of the kidney takes place and liquid accumulates in the body cavity, quickly causing death.

Two typical cases of the occurrence of calculi in the kidneys of sheep are set out below.

Sheep I. Hogget (12 months). Bred and died on the property. One enlarged kidney containing a number of small stones ranging up to $\frac{3}{8}$ in. in diameter. The other kidney was normal in size but punctured. The bladder had apparently stopped functioning. About two gallons of turbid liquid were found in the body cavity.

Sheep II. Ewe (4 years). Bred and died on the property. Sheep in fair condition. Both kidneys contained stones and powder.

One kidney very much enlarged. Some of the calculi were $\frac{1}{2}$ in. in diameter in addition to numerous small stones and powder. The calculi from the large kidney weighed 41·71 gm., those from the smaller kidney 15·41 gm.

Stock Conditions on the Moutere Hills Country.

On many parts of the soil of the Moutere Hills type the results obtained by farmers from stock—both sheep and cattle—compare unfavourably with those obtained in other parts of the Nelson district where the soils possess higher fertility.

The poorer results associated with stock on Moutere Hills country are of the following nature :

(1) Low lambing returns. A census of the percentage of lambs on 33 farms in poorer parts of the Moutere Hills country shows that the average flock increase was 40 per cent. in the 1927 season. In certain instances the percentage of lambs tailed has fallen as low as 20 per cent.

(2) Mortality among sheep and cattle. On certain farms serious losses of stock have occurred. Some farmers state that the increase to the flock by lambs just balances the losses caused by the death of hoggets and ewes. In some seasons the loss of hoggets is particularly high.

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Fig. 2. Single calculus from kidney pelvis; weight 36 gm.

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Fig. 3. Kidneys of a badly affected sheep. (Notice fat shortage.)

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(3) Inability to fatten lambs or hoggets on any pastures on the Moutere type of soil unless lime and phosphate treatment has been given to the land or unless supplementary feeding is undertaken.

(4) Comparatively low wool returns. In extreme cases 3½ lb. of wool per sheep is all that is obtained.

(5) Undersized stock are a general feature—more pronounced in the case of cattle than sheep (Fig. 5). Calves are difficult to rear and are slow to mature.

(6) The bones of both ewes and cows are frequently very light and are easily fractured.

(7) In many cases both sheep and cattle on Moutere Hills pastures are in poor condition. Cows give very little milk. Meat is of poor quality.

(8) Many instances have been reported where stock have eaten earth and chewed bones and sticks.

(9) Mixtures of bonemeal and salt are eaten greedily by both cattle and sheep on several farms where a poor condition of stock is noticeable. Great improvement in the condition of the stock has resulted from bonemeal feeding.

Extract from the Report of Mr. C. S. Hopkirk, B.V.Sc. (Dept. of Agric.), on certain organs of a sheep affected with xanthin calculi.

Mr. Hopkirk, officer in charge of the Wallaceville Veterinary Laboratory, has kindly supplied a report on certain organs of sheep affected with calculi, from which the following extract is quoted:

" *Heart Muscle*—normal.

" *Bladder*—normal.

" *Thyroid Gland*—showed some abnormal activity. The follicles contained much colloid which, owing to shrinkage, incompletely filled the cavities. Lining cells were mainly cuboidal, and apparently in some of the acini there had been some degree of sloughing of cells, and in others a definite proliferation.

" *Liver*—showed marked degeneration of many individual cells, and a vacuolated condition of the remainder. Some of the sinusoids contained xanthin-like granules.

" *Kidney*.—This organ, as one would expect, showed the greatest change. The glomerular tufts were shrunken and cells pyknotic. Glomerular sacs contained a certain amount of albumen. The proximal convoluted tubules were markedly eosinophilic, and necrotic, the lining cells having sloughed in many of the tubules while others contained swollen, vacuolated, non-nucleated cells. Some deposit was noticeable in the lumen of the tubules but this debris was to be seen in greater

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amount in the distal convoluted tubules, and even in the collecting vessels where it had the yellow appearance of the xanthin calculi. The medulla of the kidney showed definite pressure atrophy with cirrhosis, while there was a further pressure atrophy of the subcapsular portion of the cortex."

The Moutere Hills Soil.

This soil type covers some 300-400 square miles of country in the Waimea County. It appears to have resulted from the weathering of large alluvial deposits laid down by some ancient river of Pleistocene age. These deposits consist of well-weathered gravels mainly composed of sandstone, claystone and greywacke, mixed with sand and fine silt. The topsoil is a loam containing some 11 per cent. of " clay," while the subsoil may best be classed as a sandy clay.

The soil has excellent textural qualities and has proved ideal for apple culture when suitably manured. Exotic trees such as *Pinus radiata* make wonderful growth on even the poorest areas of this soil.

The chemical analysis of Moutere Hills soil compared with analyses of " Bush " sick and " Waihi " disease soils is shown in the following table :

Table I. Chemical Analysis of Moutere Hills Soil.

	Moutere Hills* soil Nelson	" Bush " Sick† soil Auckland Prov.	"Waihi" Disease‡ soil Wairarapa
	%	%	%
Loss on ignition	6·1	—	12·66
Total nitrogen	0·10	0·238	0·286
Sol. in 1 % citric acid { Available P_2O_5	0·003	0·003	0·003
Sol. in 1 % citric acid { Available K_2O	0·007	0·017	0·033
Sol. in HCl Sp. Gr. 1·1 { Total P_2O_5 ...	0·025	0·02	0·02
Sol. in HCl Sp. Gr. 1·1 { Total K_2O ...	0·23	0·075	0·54
Lime requirement Fig. ...	0·32	0·375	0·36
*p*H value	5·1	—	5·3

The chemical analyses of the three soils reported in Table I show certain striking resemblances. The soils are all highly deficient in available and total phosphoric acid. The lime requirement figures are similar, indicating a great need for lime treatment. The soils, however, differ considerably in their content of nitrogen and organic matter. In texture, the Moutere Hills soil is a loam while typical " Bush " sick soils investigated by B. C. Aston are sandy silts. The " Waihi " disease soils investigated by B. C. Aston in the Wairarapa are loams.

So far as the authors are aware no xanthin calculi have ever been reported from the " Bush " sick or " Waihi " disease areas. If the

* Average for 8 samples of soil from different parts of the Moutere Hills soil type.

† Average for data quoted by Grimmett and Simpson, *N.Z.I. Trans.* 59, 401.

‡ Typical analysis quoted by B. C. Aston, *N.Z.I. Trans.* 59, 650.

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formation of the xanthin calculi is primarily due to phosphate starvation it seems remarkable that with soils showing such similar chemical criteria as those in the table, xanthin calculi should be of common occurrence on the one soil and absent in the other two. There is of course the possibility that the xanthin calculi occur in the other areas but have not been reported. It is worth recording that though the officers of the Cawthron Institute have been in constant association with the farmers on the Moutere Hills for nearly 10 years, it has only been during the last year that attention was drawn to the calculus occurrence. Inquiry then showed that the trouble was very widespread and of long standing. Mr. B. C. Aston, Chief Chemist to the Department of Agriculture, who has made a special study of " Bush " sickness and " Waihi " disease has kindly undertaken to have a careful search made for calculi in the areas where these diseases occur.

As might be expected from the high lime requirement figure and low content of phosphate, heavy liming and phosphate manuring are essential for most crops on Moutere soil.

The many experiments conducted by the Cawthron Institute have shown that excellent yields of several crops with increases exceeding 1,000 per cent. can be obtained by the use of 2 tons of ground limestone and 5 cwt. of phosphatic manure per acre. Where great exhaustion of soil has taken place English grasses and clovers cannot be established without the liberal use of both lime and phosphate. Bacterial counts made by Mr. W. C. Davies at the Cawthron Institute show that the untreated Moutere soil has an abnormally low bacterial population, and that where good crops have been established by lime and phosphate treatment a corresponding increase in bacterial population has occurred.

The Pastures on Moutere Hill Soil.

Farmers state that in the early days of the settlement of the Nelson district, after the bush was burnt, a good sole of English grasses and clovers was obtained on many farms of the Moutere Hills soil.

In those days two sheep per acre could be carried and many fat sheep were sent to the market. At the present time the carrying capacity over large areas has been reduced to half sheep or less per acre. On a considerable number of farms not more than one-third sheep per acre can be maintained.

The English grasses and clovers have long ago disappeared, being replaced by Danthonia, sweet vernal and *Agrostis* sp.

Some lotus sp., trefoil and a little white clover can be found on farms where careful stocking and management have been observed.

Over large areas of poor hill land bracken has taken possession.

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Tea-tree (*Leptospermum* sp.) and in places blackberry have a good hold on certain parts of the Moutere Hills.

As far as the investigation has gone the highest mortality of stock and also the greatest incidence of calculus trouble have occurred on farms where great deterioration in pasture has taken place.

Chemical Examination of Moutere Hills Pastures.

During the autumn of 1928, five samples of pasture were collected from different parts of the Moutere Hills soil. The samples were taken from areas which had been burnt over during the summer, and consisted entirely of young green growth from fairly extensive pastures. Little selection of individual grasses or areas by the grazing sheep was noted.

The average mineral content for the five samples is shown in Table II. The analytical data for spring pasture samples collected from particular areas where heavy loss of sheep has been experienced are also given. For comparison the average mineral content of a number of good Nelson pastures is included in the table.

Table II. Analysis of Moutere Hills Pastures.

	Moutere Hills autumn growth (av. 5 samples)	Moutere Hills* spring growth	Moutere Hills† spring growth	Good Nelson pastures autumn growth (average)
Lab. No....	—	113	123	—
CaO ...	0·61	0·49	0·56	0·80
P_2O_5 ...	0·63	0·56	0·63	1·06
K_2O ...	3·19	1·64	—	3·81
Na_2O ...	0·12	0·31	—	0·49
Cl ...	1·07	0·42	—	1·45
N ...	3·43	2·01	—	5·23
S ...	0·33	0·22	—	0·42
Fe ...	0·011	0·030	0·044	0·026
Mn ...	0·052	0·016	0·018	0·019
Total ash	11·67	10·40	—	11·51
Sol. ash...	6·15	3·81	—	9·02
Insol. ash	5·52	6·59	—	2·49

Note. All determinations expressed as percentages of dry matter.

The outstanding features of the analytical data are: (1) The low content of nitrogen and soluble ash in the Moutere Hills samples. This is particularly marked in the spring sample No. 113. (2) The low lime and phosphate content of all samples from the Moutere Hills. This is

* Collected from typical hill country where much calculus trouble in sheep has occurred.

† Collected from typical hill pasture where both sheep and cattle eat bone-meal "lick" greedily. Great loss in hoggets in certain seasons has been experienced on this farm. Calculi in the kidneys of sheep have been found but mortality accompanied by this trouble is not so high as is the case on pasture represented by sample No. 113.

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again very apparent in the case of sample No. 113. (3) The low iron and high manganese content of the autumn samples from the Moutere Hills. In the spring samples the percentages of iron and manganese are apparently normal. The abnormal figures for iron and manganese in the autumn samples may have been induced by the exceptionally dry summer and autumn experienced in 1928. Samples of autumn growth collected from certain other soil types in 1928 also gave exceptionally low figures for iron. A large increase in the iron content of the spring samples from these types has been likewise found. Although the percentage of iron in the autumn samples of Moutere Hills pasture is as low as that found by B. C. Aston[1] in the " Bush " sick pastures of the Rotorua district, typical symptoms of " Bush " sickness do not occur in stock grazing on Moutere Hills pastures. The great increase in the iron content of the spring pasture samples suggests that in months of normal rainfall the pastures of the Moutere Hills contain an adequate supply of iron. If such a low percentage of iron is a normal feature of Nelson pastures in the autumn it seems possible that the health of stock may be adversely affected during this period of the year.

Fig. 4. Typical calculus-affected sheep.

The great deficiency of both lime and phosphate in Moutere Hills pastures is revealed in all the analyses which have been made. The deficiency is strikingly apparent on the pasture of one farm where calculi in the kidneys of sheep frequently occur. The percentage of

[1] *Trans. N. Z. Institute*, 59, 406. Mr. Aston has shown that the " Bush " sick pastures are deficient in iron and that an iron ration is a remedy for the disease.

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lime falls considerably below that found by B. C. Aston in the Mairoa[2] pastures, which have been shown by him to be deficient in lime. There can be little doubt that the low content of both lime and phosphate in the Moutere Hills pastures is closely connected with the poor stock results obtained on many farms.

Examination of Milk from Cows on Moutere Hills Pasture.

The analytical data for some mineral constituents in the milk of a cow grazed solely on Moutere Hills pasture are shown below.

Table III.

	Milk (Moutere Hills)	Milk (normal)*
Ash ...	0·80	0·72
CaO ...	0·17	... 0·161
P_2O_5 ...	0·213	0·189

The animal giving the milk was in poor condition. The milk yield was low. The cow eagerly devoured a " lick " of bonemeal and salt whenever access to the " lick " was permitted. The results shown in Table III agree with those of other workers in showing that the mineral composition of milk is little affected by an exclusive diet of a mineral-deficient fodder. In the case of other cattle on the farm where the sample of milk was obtained great improvement in appearance and vigour of the animals was noticeable after several weeks' feeding with a little bonemeal every day.

Examination of the Blood of Sheep Affected with Urinary Calculi.

Some of the analytical data in connection with the blood of two sheep badly affected with calculi are given in Table IV.

Table IV. Analysis of Whole Blood of Sheep Affected with Xanthin Calculi.

	Sheep (1)	Sheep (2)
P_2O_5	0·0356	0·0340
CaO	0·0099	0·0111
MgO	0·0080	0·0080
K_2O	0·0624	0·0508
Na_2O	0·363	0·399
Cl	0·311	0·323
N	2·663	2·044
S	0·132	0·138
Fe	0·051	0·031
Mn	Nil	Nil
Total ash	0·861	0·930
Sol. ash	0·844	0·916
Insol. ash	0·017	0·014
Total solids	17·40	13·80

All results as percentages of whole blood.

Note (1). Sheep 1 yielded much more blood than Sheep 2.

Note (2). Abderhalden, quoted by Robertson in *Principles of Biochemistry*, gives the following data for the blood of healthy sheep: total solids = 17·54%, iron (Fe) = 0·038%.

* Quoted by W. Godden, *Agricultural Progress* (1928), 5, 1.

[2] *Ibid.*

Sheep No. 1 was a 2-year-old ewe—a Romney cross. It was bred on the property and weighed 52 lb. when killed. Numerous small stones were found in the kidneys. Sheep No. 2 was a 2-year-old wether—a Merino cross. It was bred on the property and weighed 49 lb. when killed. Both kidneys of this sheep were greatly enlarged and contained several large calculi as well as numerous small stones and coarse powder. The sheep was anæmic in appearance and outwardly exhibited all the symptoms of chronic kidney trouble. The most striking features of the analytical data presented in Table IV are the low content of total solids, nitrogen and iron in the blood of sheep No. 2. This is in keeping with the observed anæmic condition of the sheep and suggests the possibility that the low iron content of Moutere Hills pastures already noted in the analysis of the autumn samples has a prejudicial effect on the health of sheep.

Fig. 5. Two-year-old Moutere Hills bull, ravenous for bonemeal " lick."

Owing to the paucity of reliable analytical data for the blood of healthy sheep, it is not possible to draw definite conclusions concerning deficiencies of minerals in the blood of the sheep affected with calculi. Theiler (11) and his colleagues have shown that a low content of both total and inorganic phosphate is noticeable in the blood of animals suffering from " styfsiekte." In certain of their experiments, however, no great reduction in the total phosphorus content of the blood occurred until two or three months before the actual death of the animals.

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Under these circumstances, the lack of any abnormality in the mineral composition of whole blood cannot be regarded as proof of the absence of serious deficiency in the diet of the animals.

Examination of Bones from Sheep affected with Urinary Calculi.

The analysis of the leg bones from sheep (1) mentioned in Table IV did not reveal any significant differences from the data mentioned by other workers in connection with normal sheep. It must be remarked, however, that the sheep in question was under two years of age. Under these circumstances it is less likely that the bones would be highly deficient in either lime or phosphate. The bones of full grown cows and sheep on the Moutere Hills are, however, very thin and fragile.

Field Experiments.

In order to determine the best means of overcoming the tendency for calculus formation in sheep on poor pastures on the Moutere Hills, several sets of experiments have been initiated. The experiments include (1) the value of basic slag alone for top-dressing pasture ; (2) the value of basic slag with ground limestone for top-dressing purposes ; (3) the value of bonemeal " lick " without resort to top-dressing of the pastures. Hoggets have been placed on the experimental blocks including control areas and the weights of the sheep are being recorded at regular intervals. The experiments have now been in progress nearly four months. All the sheep have increased in weight even on the control areas. The most significant features so far resulting from the experiments are : (1) Improvement in the flora of all top-dressed areas. The percentage of white clover, lotus sp. and trefoil is already much increased. (2) Increase in the carrying capacity of all treated areas. So far the treated areas have successfully carried double and treble the number of sheep on the control areas. (3) Sheep and cattle are readily eating the bonemeal " lick " and are showing marked improvement.

The experiments have not proceeded long enough to enable conclusions to be drawn concerning the efficacy of the treatments in overcoming calculus formation.

Summary.

The occurrence of xanthin calculi in the kidneys of sheep on certain poor pastures on the Moutere Hills in the Nelson district is reported and described. The incidence of xanthin calculi is associated with poor stock results over large areas. Poor lambing returns, high mortality of stock in certain seasons, low milk yields and inability to fatten stock

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are common features of many farms on the Moutere Hills soil. On one small farm, grazing 120 sheep, no less than 12 sheep which have died or have been killed during the last six months have had calculi in the kidneys.

The Moutere Hills soil type is shown to be highly deficient in both lime and phosphate. Great increase in crop production invariably accompanies the application of lime and phosphate to the land.

The analysis of pasture samples from different parts of the Moutere Hills reveals a striking deficiency of both lime and phosphate even in the young growth. In more mature grass, the deficiency of these minerals should be still greater.

Samples of green growth, obtained after a dry summer and autumn, exhibit a great deficiency of iron and an abnormally high content of manganese. The content of iron and manganese in spring samples of green growth is normal. This suggests that a deficiency of iron is not the main factor leading to mortality of stock. Typical "Bush" sickness, moreover, a malady definitely associated with iron shortage is not known on the Moutere Hills.

Field experiments have been initiated on farms where the sheep are known to be badly affected with calculi. The experiments have not proceeded sufficiently long to enable any conclusions to be drawn concerning the effect of top-dressing and the provision of "licks" on the incidence of calculus formation. Improvement in the flora of the pastures is already marked on top-dressed areas and a great increase in carrying capacity has been effected.

Calculus formation has not been noted on the small areas of Moutere Hills soil type where good pastures have been established by lime and phosphate treatment of the land.

Questions are raised with regard to the possible effect of mineral deficiency upon purin metabolism.

The authors acknowledge the valuable assistance given by many farmers during the course of the investigation. They are particularly indebted to Mr. R. Davies, of Wakefield, who has given much valuable information and personal assistance. They are also indebted to Mr. L. Bishop for assistance in the analysis of Moutere Hills soil samples and to Mr. W. C. Davies for the photographs illustrating this paper.

The above investigation has been carried out at the Cawthron Institute in connection with the Empire Marketing Board's Scheme for pasture research throughout the Empire. The Empire Marketing

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Board and the N.Z. Research Council have contributed generously towards the cost of the investigation.

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CANINE HYSTERIA IN LUNDS: THIRD REPORT.

By R. A. SCOTT MACFIE, M.A., B.Sc.,
Lunds, Sedbergh, Yorkshire.

THE conclusions reached in this third report are tentative but its premature publication may be excused on the grounds that it shows a tendency to grow to excessive length and contains observations that may be immediately useful to others. Conscious that the data are numerically insufficient to justify sure deductions and not even quite clear in my own mind about the complicated processes by which the continuity of the race of ticks, and of canine " hysteria," is secured, I have nevertheless written in terms of the tick-theory, assuming for simplicity's sake that canine " hysteria " is spread by *Ixodes canisuga*, the British Dog Tick. Professor G. H. F. Nuttall has with the greatest kindness sent me a memorandum on this parasite. Its life-history is not completely known but he knew, what some veterinary authorities seem almost to disbelieve, that *Ixodes canisuga* is by no means a denizen of the fields, and that it swarms on sheep-dogs at hill-farms because they are kept in kennels where ticks can multiply. Occurring as a rule on animals whose habitat is fixed, it lays an average of only six hundred eggs instead of the thousands produced by open-air ticks, and the males are not found on the hosts which include a number of mammals and birds.* These points have a practical application

* It is possible that birds may play a part in the dissemination of canine " hysteria," for *Ixodes canisuga* has been found frequently on sand-martins and in their nests, and also on sparrows and starlings. If so, the sporadic cases that occur in towns might be explained.

because hygienists generally want to destroy ticks on the dogs: a hopeless aim unless they first exterminate them in the kennels. This tick has not been found on rats and rabbits; if they harbour it the task of extermination will be more difficult.

Several attempts have been made in this district to rid farm-kennels of ticks:—

1.—*Place Farm, Lunds.* This farm was very badly infested with ticks, and the dogs are housed in two places: a division of a three-stalled stable, and a detached building which was formerly a pigsty. Early in January, 1930, a cement floor with a drain was made in the dogs' division of the stable and the two dogs, Fan and Bob, who live there, were given wooden resting-places although bedding is still strewn on the floor to enable the dogs, when they come in wet, to dry themselves before settling in their beds. Between April 1st and April 5th, the old bedding was burnt and the whole stable, except one end-stall which was then occupied by calves, was deluged from ceiling to floor with a solution containing a pound cake of Young's poisonous (carbolic-arsenical) sheep-dip dissolved in three gallons of water, and the liquid squirted into every crevice between the stones and in the woodwork with a "Mysto" sprayer generally without its fine nozzle. Dead ticks were found in cracks in the wooden partitions. Some days afterwards the walls were carefully pointed with lime mortar. Since the two dogs who sleep there were then enjoying their winter freedom from ticks they were not dipped.

About the middle of April the pigsty was similarly disinfected, but the walls were not pointed and the dog Beaut who lives there was not dipped. On April 27th, it was reported to me that this dog had ticks, and on May 21st I saw the place thoroughly deluged again in the same way as the stable, and the walls pointed. Samples of the bedding from the barrel in which Beaut sleeps, and of damp bedding from the corner behind it, were examined, and ticks, dead and alive, found in both. The three dogs—Beaut from the pigsty, and (purely as a precaution) Fan and Bob from the stable—were washed with a mixture of eight ounces of Kur-mange (Derris root) with two gallons of water. On June 20th, the calves having been moved elsewhere, the stall they occupied was sprayed with poisonous dip and at the same time the rest of the stable, but not the pigsty, was disinfected again, and the three dogs washed with Kur-mange. Though often searched not a single tick has been found on any of the three since the dates when they were respectively first dipped.

2.—*Hanging Lund, Mallerstang.* The treatment of Place Farm was experimental, designed to discover how to exterminate ticks, and

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if an epidemic of canine " hysteria " should occur in summer, to give an opportunity of observing whether the tick-free farm escaped. The extermination of ticks at Hanging Lund had a more ambitious aim—to prevent a recurrence of the epidemic. Hanging Lund is the home of the fell-shepherd whose many changes of dogs and frequent visits to Lunds farms make him a dangerous agent for spreading any canine infection. When therefore in April three of his four dogs began to show symptoms of " hysteria," it was natural to fear that these attacks were the prelude of a new epidemic which would run a course similar to that of the epidemic of 1929. Hoping to prevent this, I visited Hanging Lund on May 5th, 1930, saw the bedding burnt, the tubs in which two of the dogs sleep cleaned and disinfected, and the kennel, which is a separate penthouse attached to the farm-buildings, deluged with carbolic-arsenical dip in exactly the same way as was the stable at Place farm. From some of the joints between stones a large quantity of brown objects that looked like eggs were washed out in clusters which separated in the stream of liquid. On the following day there was nothing to be seen, but on the morning of May 7th numbers of large blue ticks were found at the foot of the walls, having apparently crawled from their lairs while still alive, fallen to the floor and died. They were swept up, but when I re-visited the farm on May 10th, I found several that had perished similarly. This indicates that the kennel must have been very heavily infested, for most of the ticks would die before they escaped, and many would tumble into the hollow centre of the wall and never be seen.

The dog-house was pointed with lime-mortar and whitewashed between May 12th and May 14th, and some other places where dogs are occasionally put were disinfected. Towards the end of the month the fell-shepherd bought a wooden kennel in which to house (old) Bell and Jem (f.).

Before allowing the dogs to return to their quarters on May 5th, Jem (f.) was powdered with a whole canister of " Pulvex " which was rubbed in with the fingers, (old) Bell was salved with eight ounces of Kur-mange made into a paste with water, and both Sedbusk Nell and Garsdale Nell were dipped in a solution of one pound of Young's poisonous sheep-dip in 7½ gallons of water. The last three were then brushed roughly with a horse-brush which, however, was powerless to remove the still living ticks. On the following day, May 6th, there were live ticks on the two Nells, but on May 7th most of them had dropped off or seemed dead and about to drop off ; nevertheless on May 10th I found two live ticks, white but fairly large, near Sedbusk Nell's neck. No ticks had been seen on (old) Bell or Jem (f.) since the treatment, but to improve the condition of her matted hair (old) Bell

was dipped on May 7th in the same arsenical solution as had been used for the two Nells. No ticks, dead or alive, have been seen either in the kennel or on the dogs since May 10th, excepting one solitary specimen found on (old) Bell in the beginning of June. Since then the fell-shepherd has parted with some of his dogs and acquired others, and I propose to make assurance doubly sure by spraying again the kennels and other places where dogs are put at Hanging Lund, and re-dipping the dogs, early in July.

3.—*Quarry Farm, Lunds.* At this farm, the dog-place of which is badly infested with ticks, an experiment was made partly to test the efficacy of Kur-mange (Derris root) and partly to demonstrate the futility of destroying ticks on dogs unless the ticks in their kennels are destroyed simultaneously. The removal of ticks from a dog is in fact unnecessary, for they drop off naturally in the ordinary course of their life, and, if the kennel be kept clean and the bedding changed frequently, can never return. On May 14th the dogs Floss and Fan, both harbouring ticks which were not removed, were washed with a mixture of eight ounces of Kur-mange and two gallons of water, and the tub in which Floss sleeps was swilled out with the same solution. Floss was examined the next morning and two live white ticks found, but at a hasty inspection later in the day I saw only one blue collapsed tick. On May 16th, Floss was exchanged for another dog and left the district ; but I searched Fan carefully and found numerous dead ticks mostly loose among the long hair. One blue tick, not deflated, was still attached to the skin, but on removal proved to be dead. On May 21st, a week after the treatment, dead shrivelled ticks were still numerous in the hair, but a new invasion had already begun for there were also two small white living ticks.

4.—*High Hall, Lunds.* This farm is not badly infested with ticks and in consequence the dogs, who live in the stable, are seldom searched. A young dog or puppy, Fly, began to show symptoms of "hysteria" early in May, and ticks were noticed on her on May 15th though they would probably have been found much earlier if she had been examined. On May 28th the corner of the stable where this puppy sleeps was disinfected with Young's poisonous sheep-dip and a large sample of the filthy bedding was taken away for investigation but no ticks, dead or alive, found in it. Some ticks were removed from the dog, including one that was unattached and apparently unfed, and she was then washed with Kur-mange. On May 30th, she was examined and no ticks found, but on June 10th she harboured a few as did also her companion Jock. Both dogs were therefore washed with Kur-mange and the whole stable sprayed with poisonous dip, Fly's stall for the second

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time. On June 12th one tick was seen on Fly, and on June 13th two on Jock, one dead and one alive. The dogs seem not yet to be quite free from external parasites, for on July 4th one tick was found on Jock although Fly had none. They were therefore re-washed with Kur-mange.

The winter of 1929-30 was mild in Lunds until February, 1930, when there was some very cold weather followed in March by heavy falls of snow. This may have had an influence on the time of disappearance of ticks from the dogs' bodies which occurred, as was recorded in the second report, about the beginning of February. Since no daily examination of dogs was practised it is impossible to fix the exact date when they reappeared, but they were not long absent. Disregarding as enigmatic the fact that on March 31st a big tick was found loose at High Hall on a cart-saddle which had been put down on some sacks where a dog had been sleeping, the parasites were first observed accidentally on April 4th by a farmer's son who, when changing a dog's collar at Quarry Farm, noticed a few fair-sized white ticks. The dogs at South Lunds and at Hanging Lund (Mallerstang) were searched towards the end of March and no ticks found. But on April 13th about a dozen, mostly big blue adults, were picked from the two dogs at the former farm ; and at Hanging Lund ticks were first noticed on (old) Bell early in the same month. On April 14th, I found plenty, all white and most of them large, on Floss at Quarry farm : I searched carefully for smaller creatures that might be larvæ or nymphs and found none, perhaps because they would be difficult to see in the dog's long hair. At Hanging Lund ticks were collected from (old) Bell and Sedbusk Nell on April 23rd, but at that date none were seen either on Jem (f.) or on Garsdale Nell who then slept in a separate place : nevertheless Jem (f.), sleeping in the dog-house with (old) Bell and Sedbusk Nell is unlikely to have been free from them, and they were found on both dogs a few days later.

I have no information about the forms in which our ticks hibernate : they may have spent the two cold months when they were absent from the dogs' skins either as eggs, larvæ* (unfed, fed and ready to moult, or actually moulting), nymphs (unfed, fed and ready to moult, or actually moulting), or as unfed adults. It seems improbable that the early arrivals could have been hatched from eggs and have gone through all their metamorphoses during the cold weather, and it may be that the

* Professor Nuttall tells me that in his own experiments the larvæ of *Ixodes canisuga* survived unfed for 348 days, the males for 123 days, in corked bottles at room temperature with a little moisture. The longevity of females and nymphs is still unknown, but does not greatly concern us, for under our conditions a tick will seldom have to wait long for a meal. It might become important if a kennel were disused for a period and then reoccupied by dogs.

adult females, which alone we have learned to recognize, reach their hosts in a series of waves, the first having hibernated as adults, the next as nymphs, the third as larvæ, and the last as eggs. Immediately after the arrival of this last wave a new series would begin, derived from eggs laid by the adults of the first and later waves. Otherwise there would be an interval during the summer when the dogs would be free from adult ticks, and the farmers assure me that no such gap occurs, though in the Cotterdale case, which will be described later, something of the kind seems to have happened.

If the whole process of transformation from egg to adult takes, say, three months, the second series of waves, or second generation of adults, would begin in July, the month which saw the commencement of the second phase of our epidemic in 1929. Little seems to be known about the time required by *Ixodes canisuga* for gorging and moulting, but Professor Nuttall tells me that gorged females begin to oviposit five to nine days after dropping from their hosts in summer, and that they oviposit during eleven to forty days at 15-19° C. The eggs hatch after 30 to 49 days at the same temperature.

There is a possibility that larvæ, nymphs and males do not disappear in winter, and that we overlooked them owing to their small size. This is improbable intrinsically, and also because in that case when, on April 1st to 5th, we disinfected the stable at Place farm and did not dip the dogs, larvæ and nymphs would have been left, some of which would later have appeared, unless the rules of cleanliness had been scrupulously observed, as easily visible adults. This did not occur. I do not know whether cold weather causes female ticks to fall from their hosts before they are fully gorged : if not, then the disappearance of females from the dogs' bodies on a certain date implies that the invasion of the dogs by unfed adults, lately metamorphosed from nymphs, must have ceased at a certain earlier date, the interval between the two dates being the unknown feeding-period of an adult female. At this earlier date presumably not only the metamorphosis of nymphs into adults, but also the metamorphosis of larvæ into nymphs and the hatching of eggs ceased also, and the eggs and unattached ticks in all stages of development must have been left paralysed with cold to hibernate or perish.

Rather thoughtlessly I feared that about a week or ten days after the reappearance of ticks there would be outbreaks of " hysteria " at all farms that were affected last year, especially if they had among their dogs individuals who had never suffered from the disease. Nothing of the sort occurred in Lunds and it became evident that the process by which " hysteria " was carried latent through the winter is less simple than I imagined. The beginning of the epidemic—if epidemic

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there is to be—was similar to the beginning of the epidemic of 1929 when the fell-shepherd's kennel was affected in April, but not all his dogs, and no other cases occurred until July. In the spring of 1930 he had four dogs :—(1) (Old) Bell, age at least eleven years. In July and August, 1929, she had had " hysteria," at first in the form of spasms of standing rigidly and barking, but later as falling fits. On January 14th-15th, 1930, she had a short illness that was suspected to be " hysteria " although it was not typical. (2) Jem (f.), more than two years old, acquired in March, 1929. She had had " hysteria " in July and August, 1929, and an illness on December 4th, 1929, that was attributed to " hysteria " although characteristic symptoms were not conspicuous. (3) Sedbusk Nell, about twelve months old, acquired at the end of March, 1930, from Sedbusk where " hysteria " was then unknown. (4) Garsdale Nell, 2½ years old, came to Hanging Lund on April 18th, 1930, from Garsdale which is free from " hysteria."

Sedbusk Nell was the earliest patient. The date of the first of her attacks is unknown, but before April 14th, 1930, they became numerous and continued to occur, roughly every other day, until about April 25th. Being in confinement she could not run but stood and barked ; there was no foaming at the mouth and she had no falling fits. On May 3rd she was reported better having had no attacks for several days, and there had been no relapse on May 5th, when I saw her dipped.

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Jem (f.) had an attack of running madness on April 14th, 1930, when shepherding on Cotter End, and was found the next day on Dent Head near the old coal-road barking characteristically. On April 28th, in the dog-house, she had numerous attacks and another on May 1st. They were all of the running type : if outside she ran in circles, if kennelled she " looked daft " and was unwilling to come out or follow her master.

Garsdale Nell, who slept in a separate place and not with the other dogs, took a fit of running madness on April 26th, 1930, and ran from near Calf Moss past High Hall to Hell Gill Brig where she waited for her master and accompanied him home. On April 28th, she had several mild attacks, and on May 1st two, in the second of which she ran from near High Hall past Shaw Parrock to her old home, Coat Weggs in Garsdale. It will be noticed that her first attack occurred only eight days after her arrival at Hanging Lund.

(Old) Bell has had no " hysteria " since the doubtful attack in the middle of last January, possibly because there is a short period of immunity which protected her until she was salved on May 5th.

The only other case of " hysteria " that has occurred this spring in Lunds was at High Hall where the puppy Fly, age about six months, developed " hysteria " early in May. Unfortunately this dog is gen-

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erally confined in a stable where attacks may easily have occurred unseen, but several were observed. The first was on May 4th, 1930, when Fly, although then outside, did not run but yelped, staggered and showed staring eyes. This attack was followed by two or three similar fits, and on the evening of May 22nd, again when outside, she had another in which she yelped, sat down on her hind legs the fore legs being rigid, and stared fixedly. On May 27th she had again an attack of paralytic type, but never foamed at the mouth. She was washed with Kur-mange, and her quarters in the stable disinfected with carbolic-arsenical dip on May 28th, and the next morning she was given 2 c.c. of tetrachlorethylene. Now Fly had a mild attack, which was suspected to be " hysteria," on January 30th, 1930, as mentioned in my second report, and if the diagnoses are correct, this did not confer an immunity that would last three months. (Old) Bell and Fly seem to contradict one another, but (old) Bell had been far more heavily infected than Fly.

The salient fact in the history of the reappearance of " hysteria " in Lunds in spring is that it reappeared only at the two farms, Hanging Lund and High Hall, where dogs had suspicious illnesses in January, which, seeing that the winter cases showed a marked tendency to depart from type, may be accepted with little hesitation as cases of " hysteria." It might also have appeared at Place farm where there was a case of " hysteria " on January 3rd, 1930, but Place farm was disinfected before ticks re-invaded the dogs. All the other farms in Lunds have escaped, including Moorcock farm where a dog showed " hysterical " symptoms on November 24th, 1929.

It must not be assumed that this is an invariable rule. There are reports of spring cases of " hysteria " in neighbouring districts which were not included in my census-area. In the beginning of April, immediately after its return from a Hawes farm to which it had been lent, a Gayle dog had a bout so serious that its owner thought of destroying it. The disease appeared early in Widdale, and there was a case near Hawes about April 15th. Two rabbiting dogs at Hawes Junction (Garsdale head) were affected almost simultaneously towards the end of the same month : one, a big strong animal, had only one fit, in which they say it attacked its master, and then recovered ; the other, an unhealthy whippet that had ticks when it was bought in Leeds market, suffered so often and so severely that it was " put down " on May 4th. A pet dog, less than a year old, belonging to a railway-guard who lives not far from this station, showed symptoms of running madness on May 8th ; and doubtless there were other cases of which I did not hear. Having no histories of these dogs I do not know whether they had winter illnesses or not. But that " hysteria " can be carried

latent through the winter without the intervention of canine agents seems probable from the experience of Messrs. W. and T. Coates in Cotterdale, an exceptionally isolated hamlet situated in the district studied.

They keep three dogs: Nell, ten years old or more, and long in their possession; Fan, age about three years, with them since she was a puppy; and Trip, a puppy of Fan, less than a year old. These dogs never leave Cotterdale and seldom come in contact with other dogs, but live in a calf-house of six pens, an excellent building with a cement floor, well pointed walls, and woodwork in good repair. Their owners believed that they never had ticks. Nell and Fan contracted canine "hysteria" about August 25th, 1929, and had attacks of running madness occasionally for several weeks thereafter. Since then Fan has never suffered from the disease, and none of the three had any illness during the winter. But Trip first showed symptoms about May 20th, 1930, and Nell began a series of attacks of running madness about June 16th, the last of which occurred on June 21st. All the attacks, both in 1929 and 1930, were mild: the dogs gave the characteristic bark, and if at large ran home, being apparently partly conscious, but had no falling fits.

I visited the farm on June 23rd, 1930,* and found that Nell had been confined to her kennel since her illness two days before. When released it became manifest that she was in a sensitive condition: her skin twitched and she trembled and ran behind bushes as if to hide. A very little excitement would have brought on an attack of "hysteria." With the help of a friend I examined all three dogs carefully and found no big ticks, but Nell had eczema and on Fan and Trip there were spots where ticks had recently been attached. We were about to abandon the search when we noticed on Trip first one, and then a second, minute tick. Unfortunately they escaped and were lost before they could be identified. Pressed for time we did not re-examine the dogs, but left with the farmers some cakes of Young's poisonous (carbolic-arsenical) sheep-dip and a "Mysto" sprayer after instructing them how to disinfect the kennels and dip the dogs. There was much lumber in the calf-house and one pen was full of peat, so that a thorough cleansing was impossible, but an attempt was made after we had gone and the three dogs dipped. A scientific friend visited Cotterdale on July 1st and found that Nell's "hysterical" symptoms had ceased abruptly after the dipping.

Our experiments in the extermination of ticks at Place farm, Hanging Lund and High Hall were successful, but it is still too soon

* I took with me, on this expedition to Cotterdale, my Alsatian and fox-terrier. The former developed "hysteria" on July 4th, 1930.

to know whether the absence of ticks will coincide with absence of "hysteria." One result, astonishing and unexpected, has, however, already followed. It will be remembered that at Hanging Lund three dogs had shown "hysterical" symptoms this spring: Sedbusk Nell, affected from about April 10th to April 25th; Jem (f.), from April 14th to May 1st; and Garsdale Nell, from April 26th to May 1st. At High Hall a puppy, Fly, had the disease between May 4th and May 27th; and in Cotterdale Nell suffered from it from about June 16th to June 21st. The kennel and dogs at Hanging Lund were cleared of ticks on May 5th; those at High Hall and in Cotterdale on May 28th and June 23rd respectively. Since these dates none of the five dogs has shown any symptom of "hysteria"—the means we adopted to destroy the ticks have also cured the dogs; and, since we employed several different parasiticides, we may almost argue that any course that exterminates ticks will also cure canine "hysteria." It should, however, be kept in mind that the drastic method we used must have exterminated simultaneously every other possible carrier.

In terms of the tick-theory this may mean that an infective tick injects into the dog's blood some poison, a continuous supply of which, either by the continuous presence or by successive invasions of such ticks, is necessary to maintain the disease in the patient. The removal of ticks would then stop the supply of poison and the dog would recover. This idea derives some support from the fact that there have been several cases of dogs who have had one mild attack of "hysteria" and never another. I believe, without having statistical evidence to prove it, that such cases occurred at farms where the dogs are only slightly or seldom infested with ticks, their treatment and kennels being such that ticks cannot multiply, and that the infection was adventitious. The bad cases of "hysteria," where the dogs have had a series of attacks culminating in falling fits, have occurred at farms where the dogs are always heavily infested.

The tick-theory cannot be stated with any precision of detail until several points, for instance the time taken by *Ixodes canisuga* at each metamorphosis to feed and moult, are more exactly determined; but on certain other points our experience in Lunds throws a little dim light. The following deductions may be worth drawing even if, in so doing, I hang a heavy load of theory on a slender thread of evidence.

The incubation-period of canine "hysteria" seems to be short. Examples have already been given of dogs who exhibited symptoms eleven and five days respectively after their arrival from a district where the disease was unknown. To these can now be added the cases of Garsdale Nell who had her first attack eight days after coming from Coat Weggs to Hanging Lund, and my Alsatian which developed

symptoms eleven days after visiting Cotterdale. The variation is easily explained by the facts that the period is probably variable and that a dog is not necessarily infected immediately it reaches an infected farm.

On the question of immunity our evidence is not clear. Without records of temperatures, it is difficult to say when an attack of " hysteria " ends, for a dog in the sensitive condition may, if protected from excitement, exhibit no symptoms. Still, there were in 1929 half a dozen cases of dogs, exposed *ex hypothesi* to continuous danger of infection, who enjoyed intervals of one to three months between attacks, and it is noteworthy that the later attacks were mild. It has already been remarked that (old) Bell who had a serious attack in July, 1929, and another doubtful attack in January, 1930, escaped in spring; while Fly at High Hall, whose January illness (her first) was mild, did not.

Transmission experiments were attempted with ticks from " hysterical " dogs at the Wellcome Physiological Research Laboratories and at the Institute of Animal Pathology in Cambridge. From the former Major Thomas Dalling reports that the ticks sent would not re-attach themselves to dogs even after they had been carefully fixed on by means of bandages, etc. At Cambridge, Professor Nuttall selected eleven females and one nymph whose mouth-parts appeared to be uninjured and handed them to Professor J. Basil Buxton, who writes that three attached themselves readily and fed in a satisfactory manner: and that two others fed for a shorter period. The dogs, however, did not contract " hysteria."

No experiments have yet been made to ascertain whether a " hysterical " dog's blood is infective and, if it is, for how long it remains infective after the symptoms of " hysteria " cease. The period of infectivity towards ticks cannot be a long one, for in that case the disease would have been carried through the winter by the dogs and communicated to the ticks when they recovered their activity, and the epidemic of 1929 would have been followed in the spring of 1930 by an epidemic even more serious. This did not happen, and "hysteria," carried through the winter apparently by ticks alone, instead of being cumulative like an avalanche, reappeared at only two farms.

On the other hand, if the tick-theory prove true, an infected tick must remain infective for a long time, as is shown by the spring outbreaks of " hysteria " at farms where there was no winter illness. In Lunds, apparently, all nymphs that had fed on " hysterical " dogs were fortunate enough to become adults and find new hosts before winter came. Elsewhere, probably owing to the removal of the dogs from one kennel to another, some nymphs were not so lucky: in Cotterdale,

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for instance, they had to wait eight months, from September until May, before finding an opportunity to spread the infection.

Judging mainly by new infections our epidemic was divided by intervals of two months into three phases, of which the second was the most important both in duration and incidence. The first lasted from mid-April to the beginning of May; the second from mid-July to the end of October; and the third occurred in January and February. This last phase, interesting because the disease appeared in an abnormal form and because it seems to have been in Lunds the means by which "hysteria" was carried through the winter, was sharply separated from the first phase of the next season's potential epidemic by two months during which the malady was completely absent; the third phase was almost as sharply separated from the second, but the second was connected with the first by the occasional exhibition of symptoms in dogs that had developed "hysteria" during the earlier phase. It seems now probable that the attack, consisting of three uncharacteristic fits, from which one of the fell-shepherd's dogs died in December, 1928, or January, 1929, was really "hysteria" of the third phase, and was the origin of the disease in Lunds.

Assuming that, as in the case of Redwater fever and the tick *Hæmaphysalis punctata*, the eggs do not carry infection but that it is transmitted mainly by adults which as nymphs have fed on a "hysterical" dog, this division may be explained by supposing that the winter-cases of the third phase, few in number, dropped gorged nymphs, which after hibernating recovered their activity and became adults in spring, invaded dogs, and started the first phase of a new epidemic. In the course of this first phase the infected dogs would receive other waves of ticks which had hibernated as larvæ or eggs, and after a period which depends on the time required at each metamorphosis to feed and moult and seems to be about three months, would again drop infected nymphs and give rise to the second or summer phase of the epidemic. That phase may be double, including two generations of ticks, and the third or winter phase may be retarded owing to the colder weather of autumn.

It seems on the whole improbable, unless the disease is re-introduced from outside our district, that we shall have in Lunds in 1930 a summer phase of the epidemic of canine "hysteria" of which the cases already mentioned might have been the first phase. The puppy, Fly, at High Hall never leaves the farm, and the three dogs belonging to the fell-shepherd had only three weeks (from about April 14th, when the disease appeared, to May 5th when the ticks were exterminated at Hanging Lund), in which to spread the infection. During this time hibernating unfed nymphs would have had to attach themselves to the

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dogs, gorge, and drop off, and the odds are heavily against their falling in another farmer's kennel. Moreover, the farmers, having been warned, may now be careful not to put visitors' dogs in their own dog-houses, and may sweep them more often, and the period April 14th to May 5th is not one when the fell-shepherd does much visiting, falling as it does after the lambing season and before shearing.

If the history of the Lunds epidemic has thrown a little light on canine "hysteria," that is all to the good, but it was not our aim. Our aim we seem to have achieved by stumbling on a cure for those of our cases that do not cure themselves and a method of arresting the progress of our epidemic. In so doing we have destroyed the opportunity for further study and must leave to the scientists—to certain of whom and especially to Professor Frederick T. G. Hobday, C.M.G., F.R.C.V.S., and to Professor George H. F. Nuttall, F.R.S., we owe a very heavy debt of gratitude for encouragement and help—must be left the researches that will lead to more exact knowledge. If another report be needed from Lunds, I hope it will be similar in tenor and length to the celebrated chapter on "Snakes in Iceland."

Clinical Article

Stomach Staggers.

By FRANK CHAMBERS, F.R.C.V.S.,
Wolverhampton.

On May 23rd, 1930, I was asked to see a four-year-old Shire mare very heavy in foal. The owner stated that at times she would go very giddy and stagger forward. These attacks passed off in a few minutes when the mare would commence to graze quite normally. She would graze for half an hour and would then be attacked again. I saw her in one attack when she appeared to be sleepy. There was inco-ordination of movement, the eyes would be partially closed and if one attempted to move the mare she would stagger forward. Temperature varied between 102 to 104. Pulse was very rapid. The mare was bred by the owner and had never had any illness during her life except an acute attack of muscular rheumatism (?) when she was a yearling. This she got over in three weeks. That she was suffering from a type

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of stomach staggers was obvious but the cause was obscure. Was it due

(1) To a calcium deficiency ?
(2) To a type of grass sickness ?
(3) To the presence of a Psammoma ?

The latter condition could be put out of court as the symptoms were not constant. The symptoms in no way resembled grass sickness for there was no difficulty in swallowing and the mare ate well at times.

I injected subcutaneously 10 c.c. of Osteolin. On the 24th May the mare was no better so I injected 300 c.c. of a 10% solution of Calcium Glauconate. On the 27th I injected a further 300 c.c. On that day when I went to see the mare in the field all the use had gone out of the near hind leg and when made to walk she progressed on the fetlock joint. The owner stated that the use came back into the leg at night and that she walked well next morning. On two occasions during her illness I passed the stomach tube and gave her formalin and salt.

The mare died suddenly on the 29th and I made a *post-mortem* the same day. There was a large clot in the internal saphena vein of the near hind leg. On opening the abdomen the stomach appeared as a huge mass. I thought at first it was the uterus but on making a closer examination found that there was an abscess subperitoneally situated on the larger curvature of the stomach containing four gallons of thick semi caseating pus. The rest of the organs were normal and I could not find any other abscesses. This abscess may have been the result of a mild attack of strangles that the owner had not noticed or infection carried through the mucous and muscular layers by a bot or other parasite. There were numerous bots in the stomach and many schlerostomes in the intestines.

Abstracts of Current Literature

Vajda, of Budapest.—The Giving of Fluid Medicines by the Mouth and the Injection of the same by the Nose in Swine.—*Tierarzt, Rundschau*, year 34, No. 70, pp. 367-370.

THE use of drugs for pigs by mixing in the food is only possible when the medicine is tasteless and odourless and when the ailing animal has not lost its appetite. Electuaries of nasty tasting or smelling drugs are only partly masticated and taken by the mouth. Fluid medicines

by proper fixing of the swine are given with difficulty. Here a sitting helper takes the pig between his knees and holds the crossed fore limbs firmly. A second helper holds the subject firmly by the ears with the head up. A third puts in a wooden gag with one oval opening and fixes it with both hands tight in the corners of the mouth. Thereupon the fluid is poured slowly through the opening in the gag with the head of the pig held horizontally. In this way failure to swallow cannot occur. This method as well as the giving of capsules by forceps and gag are time wasting and necessitate a number of helpers. For this reason the author gives medicine by the nose.

The introduction of a thin catheter through the nose into the œsophagus of swine is difficult and if the instrument enters the pouch of mucous membrane which forms the aboral cavity of the throat, an injury by penetration of the mucous membrane is possible. After favourably conducted experiments in swine, V. now injects fluid medicine through the nostrils. A helper sitting down, holds the pig in a sitting position fixed between his knees and holds the fore-feet with his left hand and compresses the mouth tightly with the right hand and brings it into a horizontal position. Then the core of a record syringe is introduced into the nostril, the edge pressed tightly up to the snout and 3 drachms of fluid injected. After each injection the mouth is set free for 1 or 2 seconds. In this way 8 or 9 drachms can be injected in about 15 seconds. After the last injection the pig is held for about 10 seconds in the sitting position so that any fluid in the nasal passages can flow away down the œsophagus. By this method 2,000 swine have received medicine, and in no case was there failure to swallow. Since, however, almost exclusively oily (castor oil and vermifuges Kebal) medicines and only in a few cases fluid medicines have been injected, V. holds it to be advisable, before general introduction of the method for fluid medicines, that extensive tests should be made in practice.

Miyagawa and Saito.—On the Biological Rôle of the Yellow Body of the Ovary.—*Japan Journal of Experimental Med.*

We are still ignorant as to the function of the yellow body of the ovary. Histologically one differentiates the yellow body of menstruation from the yellow body of pregnancy, but one knows not whether their rôle is identical or different. To elucidate this obscure point the author made use of female guinea-pigs and white rats and studied on them the effect of injections of numerous substances such as the yellow body, the interstitial gland of the ovary of a non-pregnant cow, the yellow body of a pregnant sow, follicular fluid, uterine mucus, placenta, fœtus, etc.

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1.—The yellow body of gestation can, contrary to other substances placenta, fœtus, etc., bring about the characteristic modifications of pregnancy in the genital organs of the non-pregnant female, uterus, vagina and mammary glands. These modifications cannot be produced in the same degree by other substances.

2.—The changes produced in the hypophysis the thyroid body, the suprarenals and the pancreas are identical with those which are presented by the organs of a pregnant female used as a control.

3.—Injections of extracts of fœtus, placenta arouse similar modifications to those of pregnancy in a part but never in the whole of the organ.

4.—The menstrual yellow body, the liquid of the ripe follicle, the interstitial gland of the ovary, the uterine mucus exercise no action on the organs comparable to that of pregnancy.

5.—The active substance of the yellow body of pregnancy is soluble in water, alcohol and ether.

This special substance which can produce in the female genital apparatus and in the endocrine glands modifications corresponding to the physiological modifications of gestation, the author proposes to call " hormone of the yellow body." This hormone does not exist in the yellow body of menstruation, the ripe follicle, in the ovary, nor in the uterine mucus.

Veberreiter, O.—Traumatic Luxation of the Femur of the Dog.—*Arch. f. wissen. u. prakt. Tierheilkunde*, 60, 4 pp. 312-329.

THE author has seen many luxations of the femur in the dog and attributes the accident to the relatively shallow acetabulum and the scalloping of the head of the femur. In the majority of cases the luxation is supraglenoidal anterior, quite seldom supraglenoidal posterior. Cure takes place after reposition of the head of the femur and subsequent turpentine and camphor spirit treatment. Reposition is conducted under general narcosis in order to overcome muscle stretching, to spare pain and to secure a period of rest to the patient after the reduction. Reposition is effected by fixing the pelvis and drawing the limb obliquely backwards and outwards. The limb is then rotated somewhat outwards, and whilst carrying it and bending it forwards to the belly it is abducted. Immediately after reposition a subcutaneous injection is made at two places in the region of the hip joint of 1 to 1½ c.c. of a mixture of equal parts of oil of turpentine and spirits of camphor. An aseptic phlegmony then arises which infiltrates the joint region ; this will effect a fixation of the head of the femur and hinder the slipping out from the joint cup or at least make

it difficult. With this treatment good results were obtained. Of 32 cases which have been under observation for two years 30 have recovered; one animal died and in one other the femur was luxated again in eight days.

McGaughey, C. A., M.R.C.V.S., D.V.S.M., and Downie, A.W., M.D., —Preliminary Report on an Outbreak of Fowl Paralysis in England.—Reprint from *Journal of Comp. Path. and Therapeutics*, March, 1930.

THESE two investigators of the Department of Bacteriology and Preventive Medicine of Manchester University have been conducting research into fowl paralysis occurring in England. Doyle and others called attention to the disease from 1926 to 1929. Mr. G. C. Morguson, M.R.C.V.S., sought the aid of the Department in the diagnosis of the disease in a flock of poultry which affected by birds bought in 1927 developed serious trouble from August to December, 1929—700 to 800 birds dying after showing signs of fowl paralysis.

The disease appears suddenly, generally in autumn and is most prevalent and severe in birds from three to eight months old. Clinically it develops slowly and affected birds may live over three months, but seldom recover. There may be drooping of one wing, lack of co-ordination in walking, spastic paralysis, increased reflexes and clonic spasms. Complete prostration follows and the birds lie helpless and immobile. All desire for food and water is lost and diarrhœa and incontinence is often seen.

The authors found widespread lesions in the peripheral nervous system but no gross lesions in the brain. The absence of total paralysis in the wings and legs of birds showing microscopical changes in the nerve roots of the corresponding regions of the cord suggests that the nerve fibres were not destroyed or merely affected by the pressure of the infiltrating cells.

The reprint of 76 pages contains some excellent reproductions (9) of the microscopic appearances of the nerve tissues from photos taken by Mr. H. C. Taylor of the Manchester University.

Junack.—Tuberculosis of the Pig of Avian Origin—*B.T.W.*

THE characteristics of porcine tuberculosis are very variable: sometimes bacilli are numerous and at other times scanty or very rare; certain lesions produce very grave experimental tuberculosis in the guinea-pig; with others negative results are frequent or only a localised tuberculosis occurs. Twenty years ago tuberculosis of the pig was stated to be due to attenuated bacilli probably of human

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origin. To-day it is known that infections in the pig are frequently of avian origin and that they differ in their expression from lesions provoked by the bacilli of mammiferæ.

At the abattoirs of Kottbus, near Berlin, Junack found in caseous foci in numerous pigs the presence of numerous bacilli of Koch; guinea-pigs inoculated remaining most often refractory to experimental inoculation. Bacilli isolated from caseous foci from the intestinal lymphatic glands developed well on glycerinated potato. Fowls inoculated with these cultures gave a well marked peritoneal tuberculosis, passing later on into a generalised tuberculosis. White mice quickly contracted a generalised tuberculosis; the bacilli were little virulent to the rabbit.

As a result it is ascertained that tuberculosis of the intestinal glands of the pig is most frequently of avian origin. Christiansen puts it at 72.8 per cent., van Es and Martin at 88 per cent., and Griffith, in America, at 36 per cent. Plum considers that the avian bacillus may invade the uterus of the cow and give rise to abortion.

In man, up to now, 21 cases of avian tuberculosis have been described. According to Lowenstein, the avian bacillus often gives rise to a tuberculous septicæmia.

Conclusions.

1.—Tuberculosis of avian type is frequent in the pig; cases of acute tuberculosis of avian origin are not rare.

1.—Tuberculosis of avian origin has little tendency to calcification in the pig. Caseation only exists in the intestinal lymphatic glands and in the lymphatic glands of the neck and pharynx.

3.—Staining of avian bacilli is easy, but the action of Ziehl has sometimes to be prolonged for 30 minutes.

4.—White mice are the best laboratory reactors for the study of tuberculosis of the avian type.

Günzel.—The Fight Against Tuberculosis in Denmark.—*B.T.W.*

In the different provinces of Denmark tuberculosis varies from 30 per cent. in Jutland, to 5 per cent. in the island of Bornholm.

All measures are taken to keep the milk and milk products free from tuberculosis. Foreign clients are insisting more and more on guarantees of an exact nature in the sale to them of exported dairy products. Transactions are only possible as regards subjects having given a negative reaction to the tuberculin test.

Bangs method which is used in Denmark comprises:—

(1) Rational breeding of young stock;

(2) Systematic use of tuberculin;

(3) Isolation of animals not having reacted to the tuberculin test. It is superfluous to insist on the importance of No. (1).

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The tuberculin test generally comprises the intradermic injection of 0.1 grammes of a mixture of equal parts of tuberculin and ½ per cent. carbolic acid. Some authors recommend injection at the caudal fold, but the greater number of veterinary surgeons inject on the lateral aspects of the neck ; a difference of at least 4 millimetres is considered as positive. If the ocal swelling ascends to 3 to 3.5 millimetres, the reaction is considered doubtful. The thickness of the cutaneous fold is measured before injection, then 48 and 72 hours after injection. With a view to avoiding doubtful reactions, Tallgren recommends a simultaneous injection of bouillon on the opposite side of the neck. If the reaction to the injection of bouillon is negative or insignificant, the stronger reaction obtained as a result of the injection of tuberculin may probably be regarded as positive.

The ophthalmic test is rarely used because reactions are of a short duration and may pass unperceived. The subcutaneous test has been discarded.

The tuberculin test is repeated every 2 years and once a year in the herds not completely healthy.

Since 1898 Denmark has made obligatory the pasteurisation of the sub-products of the dairy returning to the farms.

It is declared in Denmark that fowls play a big part in the propagation of tuberculosis, the malady having been established in the pigs of owners with cattle free from tuberculosis. Bacteriological examination of tuberculous glands of pigs showed the presence of avian bacilli. Plum has demonstrated that the avian bacillus has a particular affinity for the uterus of the cow. Fowls are generally isolated from bovines and pigs, and numerous poultry societies have ordered compulsory tuberculinisation with elimination of reactors. The law of Feb. 5th, 1904, provided for the reimbursement of the expense of the test to owners who agreed to apply Bangs procedure on their holdings.

The results of tests by tuberculin made at the expense of the State are as follows :

Year	No. of Cowsheds	No. of Animals	Reactors per cent.
1920	937	31,050	10.8
1921	1,187	36,720	13.2
1922	1,670	47,627	11.9
1923	2,511	40,941	7.0
1924	2,337	37,884	7.2
1925	1,322	28,649	7.1
1926	939	22,650	6.2
1927 up to Dec.	1,505	32,794	5.3

This table does not comprise tests made for private folk, thus a great number of tests were made by co-operative dairies, the expenses being paid by organisations other than the State.

The initiative in the fight against tuberculosis is taken up by :

(1) Owners who wish to have tuberculosis-free cattle at their own expense ;
(2) Associations formed for the establishment of healthy herds ;
(3) Co-operative and private dairies.

The associations and co-operative dairies seek to create regions completely free from tuberculosis analogous to the " accredited zones " of the

United States. Associations exist extensively in the Island of Seeland and are composed of farmers and small holders of a region, associated for the purification of their sheds under the direction of a veterinary surgeon. This example has been followed later by co-operative dairies which agree even to subsidies when particularly high percentages of tuberculosis arise.

Centres for the utilisation of reacting animals have been advised.

The co-operative dairies have achieved excellent results in the anti-tuberculosis fight. In 1923, nineteen dairies in Bornholm could count 30 per cent. of healthy effectives; at the end of 1928 the percentage of effectives varied between 95 and 96 per cent. Of 260 sheds affiliated with the central dairy of Gadeby, 212 are to-day free from tuberculosis. Of 2,693 cattle tested only 138 positive results were obtained. The percentages of tuberculosis in this dairy for five years were as follows: 1923, 15.8; 1924, 10.8; 1925, 7.2; 1926, no tests on account of F. & M. disease; 1927, 5.4.

One dairy at Bornholm has only a figure of 2 per cent.

Numerous municipalities enact that all cows whose milk is delivered for human consumption must be submitted to clinical examination by a veterinary surgeon every 2 months, the milk besides being submitted every month or every 2 or 3 months to a bacteriological examination. Since 1898 slaughter and compensation by the State for all cows affected with mammary tuberculosis is obligatory. This law has been extended to include notification of all other forms of open tuberculosis, slaughter and compensation.

The Danish agriculturists are well informed about tuberculosis; it is quite exceptional to find lean or emaciated animals affected with open tuberculosis, the owners take precautions on the appearance of the first symptoms.

G. M.

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Therapeutic Notes, Jan., 1930, No. 1.

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